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THE COMMERCE OF CHEMISTRY[1]

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I

A GLANCE at the pages of history will show the close relationship which chemistry has held with the advance of the human race. From earliest times, as evidenced by Biblical records, as well as by the monumental records of Egypt and the writings of Herodotus and Pliny, chemistry as an art played an important part in the life of ancient civilizations. Even as late as the fourteenth, fifteenth and sixteenth centuries the alchemical system attained wide-spread favor, and, as in the ancient Egyptian temples, chemical laboratories were to be found in Christian monasteries.

The chemist in the past has been somewhat inclined, like his illustrious predecessor, the alchemist, to lock himself up in his laboratory and keep his secrets to himself. In more recent years, however, he has come out into the light of day and now presents the results of his studies before meetings of our society and publishes his results in our journals.

Comment upon the retiring nature of the alchemists' successors, however, should not be taken in any sense as decrying the dispositions of our "fathers in chemistry" or deprecating their labors. None of us would think of criticizing the scientific habits of Boyle, Priestley or Bertholet; of Liebig, Kekule, Pasteur or of many of those who came after.

Many of these and other illustrious men did apply the results of their researches to practical ends, and the Industrial Revolution caused many industries to establish chemical laboratories at their own works. It was not until the trade associations came into being, however (particularly those forms of cooperative organization covering highly specialized fields), that capital may be said to have pooled its resources with

[1] An address delivered at Richmond, Virginia, May 2, 1930, before the Virginia Section of the American Chemical Society.

chemical science, looking toward the establishment of a community of interests. Scientific sections were organized, technical research instituted and the beginnings laid for studies that were later to advance both chemistry and commerce. To-day there is hardly a university in the country but has its fundamental and applied research available for industry or in the form of fellowships. For example, one well-known movement, sponsored by capital and initiated and administered by Professor Duncan first at the University of Kansas, later manifested itself in the establishment in 1911 of the Mellon Institute at the University of Pittsburgh with Dr. Duncan as the first director.

II

President Hoover, while Secretary of Commerce, in advocating and initiating the assembling of the $20,000,000 fund for research in pure science to be expended over a ten-year period by the National Academy of Sciences, insured, in his characteristic, practical way, the continuation of industry's source of strength. The reservoirs of knowledge must not dry up. The streams and rivulets flowing into the power basin of commerce must continue in volume. Fundamental research must go on, and chemistry while continuing its industrial cooperative program must not be neglectful of pure science.

Nevertheless, while fundamental research is necessary for further progress and while applied science must continue to be fostered, the resulting products of discoveries and inventions so made must be distributed in order that those who wish them may have the opportunity to get them. It would seem therefore that just as the second phase of the Industrial Revolution called for the more intensive services of chemistry, so to-day, in still another phase of our industrial life, a new science has developed calling for a sympathetic understanding between chemistry and commerce, a mutual relationship between chemical production and distributive mediums. In chemical parlance, the relationship partakes of the nature of a reversible reaction in that the fortunes of the one are bound up with those of the other.

So the industrialist of vision establishes and maintains a department devoted not only to working out problems involving plant operations but also to the coordination of this department with other technical departments and with the development and sales organizations.

At the last New York meeting of the American Association for the Advancement of Science, Dr. Redman presented a very interesting study in which he discussed mortalities in the several stages of a product between the time of invention and the time of successful distribution. While one would not go so far as to say that all these deaths could be averted, it seems reasonable to presume that economic research should diminish the casualties. Obsolescence, the price of progress, can certainly be met just as problems of supply and distribution are met and surmounted.

This necessity for a larger knowledge of economic conditions as they affect the chemical industry has evolved a new order of workers made up in large measure of those possessing both commercial and chemical training. It has introduced a new chemist classification.

Perhaps it may not be necessary for the chemical marketing specialist to have a chemical training, but basic knowledge of chemical science and its nomenclature should be extremely helpful in considering the fundamental aspects of chemical processes, the relation of one product to another, the possibilities for new and more efficient applications of them, as well as a more intelligent understanding of economic and commodity trends. Through these influences and trends, chemistry is recognized as basic to all industry, and chemical industry to-day exercises a profound influence upon the political economy of the world.

III

Economic trends or commodity tendencies may be caused by several factors among which may be noted (1) the influence of other industries upon chemical evolution and (2) the intrusion of synthetics into fields of use already occupied by natural products. To these factors of outstanding interest to the chemist may be added (3) those of availability of natural resources and (4) waste and co-product utilization.

Consider how the automobile has affected chemical trends. It has caused a demand for more durable materials, for new and brighter colors and new and better protective coatings. These latter have demanded solvents answering certain exacting specifications. The automobile industry is responsible for the development of anti-knock agents used as motor fuel constituents embracing a variety of substances useful for that purpose. Increased production of artificial leather followed the greater output of motor cars. This greater output was also reflected in a larger consumption of synthetic resins. Another industry that has affected the trend of certain chemical commodities is the rayon industry. Rayon—itself a group of chemical compounds—has exercised an influence over cellulose and the acids, both nitric and acetic. The demand for acetic acid, for instance, increased to such an extent that calcium acetate had to be imported to satisfy the demand for the raw material, despite a continued growth in synthetic production as well.

Not so long ago the number of synthetics entering into competition with natural products was small, but

the rapid progress in chemical discovery adds new ones to the list almost daily. Ammonia, acetic acid, methanol, ethanol and the aromatics are just a few. Glycerin is confronted with glycol, and butyl alcohol faces internal dissension. Citric acid from fruits faces the constructive activities of the molds. The scene of natural camphor production will quite probably shift from the wild highlands of Formosa where live the head-hunting savages to more refined scenes of synthetic production.

Every state and territory in the union is endowed with a wealth of natural resources, ranging from mineral deposits to forests and power sources. Abundant deposits of salt and gypsum, pyrites and sulphur, are to be found in certain localities; oil, coal, gas and limestone, clays, phosphate rock and bauxite in others. In short, our natural resources comprise practically everything to be found in a text-book on economic geology. The animal and vegetable kingdoms, likewise, to a great degree contribute a variety of materials which after processing finally enter into commerce.

Utilization of wastes and collateral products is constantly changing our ideas as to what are main products and what are by-products. Once kerosene was the principal product of a petroleum refinery; now the situation is reversed. Hydrochloric acid at one time was allowed to escape as a waste gas. Uses found for it soon made it a main product. The oils obtained from by-product coke ovens are to-day in as great demand as the residual product of distillation. Chemical history is replete with these reversals in relative economic importance of manufactured products.

IV

The consequent appearance of new products and the larger application of both old and new ones have brought about a situation not comparable with that of any previous period in history. The incidence upon life of enormous quantities of materials having manifold uses must be characterized as truly great.

In the twenty-five-year retrospect of the American Chemical Industry, recently issued by the Chemical Division at Washington, and in Professor Munroe's great work on chemical technology prepared for the Bureau of the Census in 1899, there are presented more than the mere chronology and statistics of the industry. Considering these along with the younger Silliman's contribution to American chemistry, presented at the Northumberland celebration in 1874, it would be possible to write the history of American chemistry.

The magnitude and scope of chemical industry today is tremendous when compared with that of a hundred years ago—even indeed within the past quarter of a century. A comparison of the 1899 production figures with present-day ones will afford an idea of how far we have traveled since that time.

Consider just a few outstanding examples:

	1899	1927	
Acetic acid	\$ 400,000	\$5,500,000	(for sale)
Nitric acid	1,500,000	3,500,000	"
Sulphuric acid	7,300,000	43,000,000	"
Mixed acids	1,100,000	3,800,000	"
All sodas and compounds	11,600,000	114,000,000	
Alums	2,400,000	9,500,000	
Cyanides	1,600,000	6,300,000	
Fertilizers	42,000,000	190,000,000	
Paints and varnishes	54,000,000	500,000,000	
Explosives	17,000,000	72,500,000	
Plastics	2,100,000	28,000,000	

Sulphur, in the 1899 figures, included pyrites, and production aggregated a value of \$543,249. The 1927 production of sulphur alone was valued at over \$38,000,000.

Rayon, first exhibited at the Paris Exhibition in 1889, is now a firmly established industry, total United States production in 1927 amounting to \$110,000,000.

Medicinal and toilet preparations, crude drugs, essential oils, waxes, matches and a multitude of other commodities have also seen a remarkable development.

We can not leave this discussion of the rise of the American chemical industry, however, without mentioning a branch constituting a key industry and occupying an important position in the chemical life of the nation—the synthetic organic chemical industry. In 1880, when the first mention was made in the census returns of coal-tar dyestuff manufacture, production amounted to 80,518 pounds of aniline dyestuffs. Expansion since the World War presents a magnificent record, preliminary figures for 1929 indicating the production of domestic dyes to have been approximately 110,200,000 pounds. Production of organic photographic chemicals totaled 581,000 pounds; synthetic flavors, 2,290,000 pounds; synthetic perfume materials, 1,596,000 pounds; synthetic phenolic resins, 31,471,000, and synthetic coal-tar medicinals, 5,000,000 pounds. An industry that can offer to purchase for a country, with one of its secret remedies, great areas in the tropics is not an industry to be neglected.

We have compared the present with the past in terms of production. A story of the expansion of our foreign trade would also read like a romance.

To-day the world is our market-place, and we are sending to all parts of the globe chemicals and allied products valued at over two hundred million dollars a year. On the other hand, our imports of materials for use in chemical and allied lines aggregate over

two hundred million dollars annually, two thirds of which are either exotics or supplements to our inadequate domestic supplies requisite for the promotion of our industry.

The saturation point is not in sight. Production is limited only by human needs and desires, and our economic horizons are constantly being pushed back in order to supply the rational cravings of teeming millions not yet acquainted with modern necessities, to say nothing of some of the luxuries.

V

The forward movement in American industry has been accelerated in recent years by a greater Southern participation. The creation of a New South, a new industrial South, has resulted from a recognition of its vast potential resources and the availability of cheaper power and new methods and lines of transportation. Other contributing factors are the supply of native labor, freedom for expansion and widening markets. This new state of affairs is reflected in a production value for all industries in the South in 1927 (the last census year) of $10,371,000,000, about one sixth constituting chemicals and allied products.

The textile industry particularly has exhibited a southward movement and the processing of natural fibers and the manufacture of artificial ones—essentially chemical processes—has been an important development. The cheese industry since the practical eradication of the cattle tick has moved in a southerly direction. Coincident with these migrations there has been the establishment of other new industries. Expansion of old ones is reflected in the carbon black and the naval stores industries, and to the vegetable oil industry has now been added tung oil. Finally to supplement increased phosphate rock production we have another fertilizer material—fixed nitrogen—added to the South's list of products. Carbon bisulphide is expanding; diphenyl is no longer a laboratory curiosity, and cotton seed bran, the lowly peanut-hull and the Jerusalem artichoke will probably be converted into xylose on a commercial scale.

VI

Statistical data for the South in general and Virginia in particular have been so admirably presented by one of your section, Dr. Hitchcock, that it is unnecessary here to more than mention the leading position occupied by Virginia in the production of chemical and allied products and to note some opportunities worthy of consideration.

"Down where the South begins," here in Virginia, you have entered into a new age. Already known as the "mother of industry on the American continent," the state in which "were established the first salt plant, the first glass works, the first leather tannery," you now have added another type of "first," first in production of rayon. You will also, it is said, soon be able to guarantee United States independence of foreign nitrogen.

In 1927, the value of all products manufactured in Virginia aggregated $671,000,000, a 14 per cent. increase over the total 1925 value. Of the 1927 value, chemical and allied products aggregated $129,000,000, divided into twenty groups, illustrating the diverse nature of Virginia enterprise.

At the same time, what has been done represents only a portion of what may be accomplished. A booklet recently issued by the Virginia State Chamber of Commerce impresses one with the great potentialities awaiting development. Water and rail serve not only a section that may be glimpsed from the deck of any steamer coming down the bay or in through the capes but a vast territory to the north, west and south, as well.

Hampton Roads Port is a gate of ingress to the West and South, and it is one through which a steadily increasing outflow of all sorts of materials will find their way to foreign fields. The Hampton Roads Port is especially favored by its location and the nearness to the east and west coasts of South America and by the territory which it is capable of serving. Mutual requirements of this area and the United States should ensure cargoes coming and going.

In the export studies included in the traffic survey previously mentioned is one on coal, and the thought occurs that some could be processed in ovens and the by-products utilized. Coke production could mean a metallurgical industry, and an increased tar production could mean more road materials and more domestic creosote with a short haul and perhaps an expanded creosoting industry. The manufacture of other products ranging from crudes to finished products, from motor fuel constituents to dyestuffs, is not incapable of consideration. The import study on cacao beans suggests theobromine and caffein, this thought in turn suggesting the field of fine chemicals. The molasses study not only suggests industrial alcohol but also images the booming solvents industry. Reflection upon the pork and pork products study visualizes slaughtering and packing-house activities, with consequent production of biologicals, soaps and glycerin.

In addition to these suggested lines of chemical endeavor may be added casein, not only to supply the coated paper industry, but also as a basis for the casein plastics now finding wide application.

VII

Suggestions such as the few just given inadequately present our possibilities. They seem so very meager. Could we but transport ourselves into the future—let us say to 1950—we should, no doubt, be amazed at

what had happened in the intervening score of years.

The historical glance backward has shown us the great forward strides made since earlier times by American chemistry. We are quite aware too that scientific discovery and invention are proceeding at an ever-increasing rate, and in the light of history our progress in the future is to be more rapid than in the past.

The functions, then, of chemistry in the future must be more comprehensive than at present and must certainly embrace an understanding of its economic importance. The service of chemistry must be not only in the discovery and the application of scientific and technological facts, but chemistry must also serve by solving the larger problems of distribution in its broadest sense. We must lay more emphasis upon the commerce of chemistry, upon the economical distribution of chemical wares. New uses must be found for old products. Old industries may justify expansion, and new ones would logically be inaugurated if deemed advisable.

It is not enough to visualize the great potential awaiting development—to view the perspective—and stop at that. Practical and efficient methods for bringing about the desired ends must be formulated, and happily, chemical industry itself, as well as governmental institutions, have made a beginning along this line.

A general method of approach, capable of specific application, of arriving at a program of effort, is through the chemical-economic survey. Such a survey, when completed, should show fairly conclusively whether or not a given material shall go into production, how long an industry can continue its current program, whether it should switch immediately or gradually or whether it should pick up and move to some other part of the country.

In building the survey structure the technique to be followed will, of course, depend upon the problem at hand, but no matter what the survey, whether of some particular branch of industry or of some particular commodity or group within the industry, the foundation upon which the superstructure is to be raised must consist of immediate, reliable, adequate and permanent records.

VIII

The Department of Commerce, because of its relation to other government establishments and to industry, has at hand or can point the way to the many sources of information so important in determining the position or status of a specific chemical industry or commodity, or in determining their trends. Cooperation in this respect is gladly accorded through the Chemical Division of the Bureau of Foreign and Domestic Commerce, which, established eight years ago by Mr. Hoover when he was Secretary of Commerce, with Mr. Concannon as chief, endeavors to render practical service in the application of commerce to chemistry.

Nearly every day one or more interesting problems are presented. Some one may ask, "How are the solvents?" or "What is the future of acetic acid and how?" Or the question may be, "Where and in what quantities can rotenone-containing plants be found? Has it been synthesized yet?"

The functions of the division are essentially trade promotive and do not include any of a regulatory nature. Through regional surveys and immediate services available in fifty-eight American cities the bureau assists domestic commerce. To promote foreign commerce the bureau also has available the services of its fifty-six offices abroad and the collaboration of the consular service.

The information thus made available covers a multitude of points: Magnitude of the situation as affected by foreign competitors, climatic conditions, advertising, make-up and habits of the population, purchasing power, chemicals and allied products manufactured locally or other sources of supply. Questions related to transportation facilities, customs tariffs and internal regulations affecting the importation or sale of American products in oversea countries are looked into and reported upon.

In addition, the bureau maintains lists of prospective agents in each country and keeps a complete commercial report on each one for the confidential use of American firms. Not only is up-to-date information given regarding trade conditions, but each week the bureau publishes a number of "trade opportunities," which are inquiries from parties with a definite interest in buying who wish to get in touch with manufacturers here.

A thousand men are at your service in the four corners of the world to gather together data bearing directly upon foreign trade promotion, and at the Washington headquarters and the district and cooperative offices throughout the country you will find the department's facilities at your disposal.

OBITUARY

GEORGE NEIL STEWART, PHYSIOLOGIST

April 18, 1860, to May 28, 1930

By Stewart's death science has lost a brilliant physiologist "of the old school," a pioneer, a builder of bridges between the founders of modern physiology of the modern era. He was a pupil of the old masters, but most of all he was a scientist of high merit in his own right and a man of personal great-

ness. He was a constructive force in physiology, a master of the subject, of its literature and its technique; an independent and critical thinker of deep insight, a conscientious and resourceful investigator, a brilliant educator of students and teachers and investigators, the author of a classic text-book.

Devoted to his work, he led a very retired life, especially in his later years, and made few personal contacts outside of the immediate circle of his friends and pupils. Toward the end he became a rather remote figure, especially to the younger generation of physiologists—and to their loss, for he was a great and inspiring teacher. Even in this personal remoteness, however, he exerted a great influence on the development of physiology in English-speaking countries, by the pupils whom he has formed and by his text-book, which introduced so many medical students to the subject. The book was the man and the subject. It breathed and lived the spirit of modern physiology, of the science and functions of life. It presented the point of view, the methods, the results, of the science in a simple, lucid style which made the most difficult things plain and interesting, and within the reach of all. It supplemented the didactic exposition with "practical exercises" which motivated and recast the laboratory teaching of physiology. In the book and in himself, Stewart typifies an important period in physiology, the transition from the dawn of physiology as an exact science of broadly applied physics and chemistry, to the present period of more detailed specialization. He carries us back to the days of largely diversified interests, when a man could still claim all physiology as his province; he helped to carry its spirit into a new country and into a new century. In this he was not alone; there were other pioneers and other bridge builders, and we are grateful that a goodly number of these are still with us. However, Stewart's significance went beyond his period; it lay largely in his personality, and its reactions with science.

I had started this memorial with a chronologic history of events in Stewart's life; but with a man of his inner individuality, externals are mere accidents, and so he regarded them. This small esteem is illustrated by the minor disagreement of the dates in his biographic calendar, in "American Men of Science" and in "Who's Who." What matter to the man whether he received his M.A. in 1881 or in 1883; one would serve him as well as another. External events were but a net on which to weave the pattern of his life. They were not vital, they scarcely show through the final design, and yet they must have guided it to a large degree. Man is like Faraday's atoms, a mere meeting point of forces, external and internal, and is formed by their interaction. To understand Stewart, therefore, it is well to attempt to list the chief external events in the order of time:

Born, London, Ontario, April 18, 1860.
Assistant in physics, University of Edinburgh, 1879–1880.
M.A., University of Edinburgh, 1881 or 1883.
Mackay Smith scholar, 1883–1884.
B.S., University of Edinburgh, 1886.
Studied in Berlin, 1886–1887 (with du Bois-Reymond).
D.Sc., University of Edinburgh, 1887.
Demonstrator of physiology, Victoria College, Manchester, 1887–1889 (under Wm. Stirling).
M.B., University of Edinburgh, 1889.
George Henry Lewes student, University of Cambridge, 1889–1893.
Examiner in physiology, University of Aberdeen, 1890–1894.
D.P.H., University of Cambridge, 1890.
M.D., University of Edinburgh, 1890 or 1891.
Studied in Strassburg, 1892.
Instructor in physiology, Harvard University, 1893–1894 (under Bowditch).
Professor of physiology and histology, Western Reserve University, 1894–1903.
"Manual of Physiology," first edition, 1896.
Professor of physiology and head of the department, University of Chicago, 1903–1907.
Married, to Louise Kate Powell, September 20, 1906 (four children).
Professor of experimental medicine and director of the H. K. Cushing Laboratory, 1907–1930.
"Manual of Physiology," last revision, 1918.
LL.D., University of Edinburgh, 1920.
Died at Cleveland, Ohio, May 28, 1930.

Stewart was born in Canada, but the family soon returned to Scotland, and he was brought up in Lybster, Wick, a little fishing village on the North Sea. The character and occupation of the people left a powerful impress upon him. He was fond of recalling the romantic adventure and hard work of the herring fisheries, the bustling markets and the cooperage. By race and contact and inclination he took on the strongly marked characteristics of the Scotch villagers, their sturdy gospel of hard work and stern devotion to duty, asking little of life and giving much; their industry and self-control and self-denial and honesty and self-respect and independence and veneration of learning. The scholar was the man respected, and Stewart early showed that he was a diligent learner and a clear thinker. He gathered a goodly stock of honors, prizes of books and medals, which pleased his family, and later of scholarships and posts of more substantial worth. Thus he laid the foundation for his career, in the medieval manner of the small village, and carried a load of boyish learning to that medieval citadel of classicism, old Edinburgh, the greatest city of Scotland, and thus of

the world. It impressed him much as the medieval university towns impressed the medieval students. The training began with the classics and philosophy and history and mathematics. The classical languages were probably a duty rather than a choice, but when he went to the Continent and presented himself to a professor whose knowledge of English was as theoretical as Stewart's training in German, they both found it easier to converse in Latin—a striking illustration of the educational changes of the last fifty years. History remained a means of relaxation to the end. Mathematics ever appealed to his sense of order and clearness and logic. It is often the gate through which a studious mind is introduced to science, and as is so often the case with a studious mind, it led him into science by way of physics. With his industry and intelligence, he stepped quickly across the gulf that separates the receptive from the active student, and became assistant in physics, to Tait, the brilliant experimenter and popular lecturer and writer.

As most scientists of those days, he took up the study of medicine to assure his future bread and butter. At that time, physiology was taught at Edinburgh entirely by formal lectures, as if it were history or philosophy; but Rutherford had done some experimental research, especially on bile flow, and a small group of students persuaded him to give them a course of demonstrations. This was Stewart's initiation into physiology. He was attracted by its boundless possibilities for the application of exact scientific methods of working and thinking to problems that appeared worth while, and he turned aside and stretched out his medical course so that he could devote himself to physiology. Through his training in physics he became particularly interested in the electrophysiology of nerve, and he spent his first year abroad with the master of that subject, du Bois-Reymond, in Berlin, in 1886 to 1887. On his return he took the doctorate of science at Edinburgh, and launched definitely on the physiologic career, but later, with Sotch caution, took also the M.D. at Edinburgh and the D.P.H. at Cambridge.

The next two years, after his return from Germany, he spent as demonstrator of physiology with William Stirling at Manchester, and obtained excellent experience in teaching methods. Stirling made a sacred cult of the illustrated lecture; and there is perhaps no better method of learning the technique and the phenomenon of a science than that of being responsible for a demonstration course. One learns to feel the importance of visualization, of the senses, as aids to understanding; one learns to think in terms of actualities instead of abstractions; and the variety of technique calls forth ingenuity and inventiveness. The wide field which must be covered in a limited time prevents narrowness and pigeon-holing. Matters are brought into apposition while they are still fresh in the mind, and in the best condition for forming connections. There is no method of preventing narrowness in a science more effective than the yearly repetition of a course illustrated by experiments. Such experiments never grow stale, at least in the biologic sciences. Incidentally, the department of physiology was further broadened by the inclusion of histology, and much of what now goes to biochemistry. The subjects have meanwhile grown so much that their union under one man would lead to superficiality; but so long as it was feasible, the inclusion of these three aspects of life, morphology, physics and chemistry, did tend to prevent narrowness of vision and specialization. Perhaps that is one reason why the investigators of that generation were apt to diffuse themselves. Nature appeared so full of various things that it was difficult to set bounds to one's interest. There were continents to be explored, while now the task is more that of the intensive development of a territory, or a mine or a chamber of a mine.

After his apprenticeship in teaching, Stewart devoted himself to research, chiefly at Cambridge, with another experience in Germany, this time at Strassburg (1892) where he formed a friendship with Cushing. In 1883 he accepted an invitation of Bowditch to come to Harvard as instructor of physiology. The experience was a happy one. He was charmed by the kindly, high-minded Bowditch, whose cordial hospitality made a stranger at home; and his imagination was captivated by the possibilities of the land, still so virginal in regard to science, so unsophisticated, so eager. He desired to prolong his stay, and embraced the opportunity which presented itself, before the year was up, by the tender of the chair of physiology and histology at Western Reserve University. Thus end Stewart's wander-years, those years of flowering freedom, when experiences and impressions are gathered and stored and worked over, when the character is forming, and plans are pushing forward, waiting for realization, crystallizing from dreams to substance.

In 1887 Mr. John L. Woods, of Cleveland, who had made a fortune in lumber, conceived the then revolutionary idea that a most useful application of wealth to the benefit of humanity would be its investment in medical education, a commodity which stood in great need of improvement. To this end, he built a monumental stone building, in the perfection of the period, for the Medical School of Western Reserve University, and founded an unconditional endowment of $125,000, one of the very few and one

of the largest medical foundations of the time. The Medical Faculty accepted the princely gift with grateful appreciation, and doubtless also with some misgivings; there was so little precedent! Some thought that the income should be distributed to the teachers, which meant the practitioners who were giving part-time clinical instruction. Others felt that this was a great opportunity to install the laboratory system, whose sun was shining abroad, especially in Germany. Could not the sun be brought to rise also in America, in Cleveland, at Western Reserve? The visionaries won; as usual, the visionaries were chiefly the younger men; and as usual, they had no fear of youth. In 1893 they secured Carl A. Hamann, aet. 25, for the chair of anatomy; and in the next year, William T. Howard, aet. 27, for pathology; and Stewart, aet. 34, for physiology. Stewart came to Cleveland to size up the situation. He liked the faculty, and he was greatly impressed with the building. Here, he told later, was a substantial place that would withstand the siege of the Indians, aye, and would be sturdy for centuries to come. It might, were progress not more destructive than the Indians. The building has been razed, and salt sown in the furrows, because the parking space was more valuable than the fortress.

Stewart took hold of the job with the enthusiasm of the young wrestler. The chance to do stirred his imagination; the task to be done spurred his sense of duty; the warm admiration of the students called for his affection; a group of younger workers, Howard, Hamann, Hoover, supplied the comradeship, the understanding; the friendly deference of the older colleagues gave him confidence. All that was Stewart warmed to the occasion. He was busy, supremely busy, but perfectly happy. The conditions, physiologically speaking, were those of the frontier, and Stewart would have been justified in spending a year in studying the situation and laying plans, and perhaps starting to develop some one feature; but his conscience did not permit him to slight anything, to defer to next year what could by any chance be done now. He had few resources except in himself, but that was enough. For apparatus, for personnel, he had chiefly his own boundless energy. It served him as the genii of the fables. He was roughing it—the greatest stimulus to men of strength and independence. The tale of his first year would be as a tale of Crusoe to these modern days. We have become dwellers in civilized and populous cities. We have gained much in externals, in machinery, in speed, in directness, in accuracy; but we have lost something of the spirit of things, of self-reliance, of adventure. Have we gained more or lost? Perhaps the question is unanswerable, or not worth answering. Our lives are cast in the present, and our dreams are dreams. The current of time and events sweeps on; the towered castles that were picturesque in the upland become vain ostentation in the plain.

The first year in Cleveland was filled and over filled with teaching; but on top of this Stewart managed to write his text-book, which he put through the press during the next summer's "vacation." It is a measure of Stewart that the book bears no trace of the pressure under which it was produced. Substance, style and proof-reading are as nearly perfect as if they had been the author's sole occupation, with time unlimited. When the book was completed, Stewart took no time for rest, but turned to research the energy and time that was released. Aside from these activities in physiology, Stewart took an active part in the forming of the important faculty policies, including the lengthening of the course from three to four years, and the requirement of an academic degree.

Thus passed ten full, busy, happy years. In the meantime Harper had started a great university in Chicago, with emphasis on graduate work. There Jacques Loeb had founded a school of physiology, temporarily divorced from medicine, with brilliant disciples. Loeb, however, desired to be relieved from all teaching duties, and had gone to a post of pure research in California. Harper was planning a medical school, and with the assistance of Barker, was seeking as successor to Loeb a physiologist who would be interested in the medical school as well as in physiology. Their choice fell on Stewart, and he again saw another, a broader opportunity and accepted. The change did not come altogether easy to him. The greater centralization was somewhat irksome to his individualistic temperament. The restrictions which were deemed necessary to the effectiveness of the larger organization cramped the man who had become accustomed to the complete liberty which prevailed in Cleveland. These matters were gradually adjusted, but in four years Cleveland secured Stewart's return by organizing a somewhat novel experiment, the H. K. Cushing Laboratory of Experimental Medicine, for the application of the method of scientific investigation to the problems of the clinic. Clinical research was lagging definitely behind the advance of the laboratory subjects, chiefly because the active practitioners who were in charge of the clinics lacked the time and often the special training for the application of the methods of physiology, of physics and of chemistry. There were no full-time salaries in the clinical positions; and even had these been available, there were few if any men who would have been properly prepared to take them. It appeared necessary to try another experiment; and it seemed worth while to establish special liaison

foundations, and Stewart, with his broad interests, appeared the man to place in charge of such an experiment. It appealed strongly to him, and he accepted. He was happy to return to Cleveland and to found a field of useful activity, although the experiment did not work out quite as it had been planned. The difficulty was largely intrinsic. The condition of success was enthusiastic collaboration between the laboratory and clinic on a basis of equality. Collaboration may be fruitful on a basis of subordination; but equal partnerships remain enthusiastic only if they are spontaneous. They are chilled by official assumption, and as enthusiasm wanes, difficulties arise. Stewart, therefore, made the activities of the laboratory self-containing and turned especially toward the functions of the adrenal gland. His later years were afflicted with ill health, an anemia with progressive spinal degeneration, which hampered his physical activity; but he kept mentally alert, and in our last conversation he repeated to me how much he liked to continue in the work.

And so, having completed the course, let us turn back and attempt once more to seize Stewart's significance to physiology. His career started when that science was passing through a formative period, especially in America. Such periods bring out the strength in men; the stuff is more plastic and takes impressions more easily; and there being fewer competitors, the impressions stand out more strongly. But Stewart's significance went beyond his period. It was a part of his personality, a something which contains intangible elements, but which also has some tangible features. Stewart's was an impressive figure in science, chiefly because he possessed to a high degree the chief characteristics of the scientist. It may, therefore, be worth while to examine these features in him. First, I would place intellectual curiosity, eagerness to know, to comprehend, this wonderful world. This desire was insatiable; everything was full of interest, presented questions, pressed for solution. His was the religion of the investigator, the scientist's faith in the value of knowledge, *per se,* of facts—provided that they be facts. This was the second feature in the personality: rigorous conscientiousness in the pursuit of truth and punctilious devotion to duty. The third feature was a keen mind, analytical, critical and logical, which led his path through the mazes of data and theory. Then came an exhaustive, encyclopedic command of the literature. To the end, the journals were conscientiously read, each paper critically sifted, abstracted and filed in due order. His judgment was reliable, severe but just in all his relations, every fact and every action received its exact due, no more, but also no less. One of his most strongly marked features was his clear exposition, the natural projection of his own mental processes. What he thought, he thought clearly; the lights and twilights and shadows each had their exact value; and what was so clear to him, he had no trouble in making clear to others; he need merely to lay it forth, to open his mind to inspection. In his teaching, as in his book, there was never a doubt as to Stewart's meaning; nothing was slurred; each datum was set forth, weighed and appraised, each argument defined. This was settled, that dubious; so much was on this side, so much on that; you could lay a wager on the odds. There was still something further, an unusual facility of thinking. To Stewart's mind, direct and logical thinking was as natural, as easy as breathing. The current of his thought flowed smoothly and rapidly and clearly. He could write and talk extemporaneously as well as after long preparation, or indeed better, for the extemporaneous had the warmth of life, and his delivery was enlivened by his whimsical dry humor, supported by an inexhaustible fund of anecdotes. The extemporare in Stewart's delivery and writing, however, was merely in the form, in the expression, in the vestment. Behind it lay thorough preparation of the substance. The material for his lectures and demonstrations was prepared with the thoroughness and attention to details which he had learned in the Stirling days. He exacted similar thoroughness from his students, and he was a master in exposing the slipshod. With a few artistic moves he peeled off the cloak, the skin, the muscles, the bones, and reduced the hapless victim to a shadowy cloud; and all this with such evident absence of malice that a culprit learned an unforgetable lesson without taking offense; the lesson of clear, straight, logical thinking, based on facts obtained from reading and from the original source in the one true sense, experimentation. The latter was the special aim of the practical course, to give to the students the opportunity of first-hand observation of phenomena, of as many phenomena as possible, to acquire an ample fund of experienced and visualized things as stuff for thought. The importance of this was especially great in the earlier days, when it furnished the only direct contact with life, in the entire medical course; even the clinical work was then taught almost entirely by "theater" demonstrations. Stewart, therefore, introduced considerable work on mammals, an innovation in those days, and of experiments on the students themselves. Times have changed; the medical course now includes much more laboratory work, but it is distributed among all the subjects, and, therefore, must be supplemented more extensively by demonstrations.

Research, Stewart regarded as indispensable to the self-respect of the scientist; as the thing that lifted

him above the common herd, and by which he set a marker in the flow of time. It was his religion. To it he brought conscientiousness, logic, imagination, ingenuity and a background of reading and wide knowledge of what had been done and thought and erred. The diversity of his interests is illustrated by the subjects that come to my mind. In the pre-Cleveland days: color vision, electrophysiology, cardiac nerves, circulation time estimations by the dye method; in the first Cleveland period: otoliths, muscle proteins, electric conductivity and its application to the circulation time, permeability of the blood corpuscles as simple forms of life; in the Chicago period: resuscitability of the central nervous system; in the Cushing Laboratory: further studies of permeability, calorimetric measurements of blood flow, epinephrine output, suprarenal deficiency. All these show careful work and diligent accumulation of data. It is too early to judge their ultimate usefulness.

After all, however, the greatest significance of Stewart is his influence on his students, his pupils and his associates. They are all different, and better, for having been exposed to him, his high standards, his meticulous methods, his comprehensive points of view, his critical logic. I had the privilege of being the first in time; most of his other Cleveland pupils went into practice, except Guthrie, who followed him to Chicago. There his chief disciples were Carlson and Pike, and many others were partly formed by him. In the Cushing Laboratory he became associated with Marine and Rogoff and Dominguez.

To attempt once more a final evaluation, Stewart stands forth as a notable scientist of high ideals and eminent ability. His importance was not so much in his discoveries as in the standards which he inculcated. He promoted physiology as a whole. His teaching set a model of logical exposition, of clear thinking, of critical evaluation of data. He expanded the capabilities of the laboratory in the teaching of physiology. He hastened the appreciation of the experimental point of view in teaching and thinking. All who came in any contact with him were the better for the experience—which is perhaps the highest praise that can be given to any man.

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SCIENTIFIC EVENTS

THE DEPARTMENT OF ANIMAL GENETICS AT THE UNIVERSITY OF EDINBURGH

THE *British Medical Journal* reports the opening of the new department of animal genetics of the University of Edinburgh on June 30 by Sir Edward Sharpey-Schafer, F.R.S., under the presidency of Principal Sir Thomas Holland. Sir Edward Sharpey-Schafer, before declaring the buildings open, gave an address. Professor F. A. E. Crew, in presenting Sir Edward with a key to perform the opening ceremony, referred to the important work of Professor Cossar Ewart, who, he said, was fortunately present that day. Professor Ewart might well regard this department as his own creation and the realization of his dreams. The ceremony also included the conferment of the honorary degree of LL.D. upon Mr. Thomas Bassett Macaulay, president of the Sun Life Assurance Company of Canada, who had made a series of gifts to the department. In presenting him the dean of the faculty of law mentioned that, like Lord Macaulay, the present recipient of the degree was descended from the Macaulays of Uig in the island of Lewis. His father had emigrated to Canada, where their guest had built up one of the foremost insurance corporations in the world. After the degree had been conferred Mr. Macaulay said that the study of endocrinology had been one of his hobbies for at least twenty-five years. This might seem a strange recreation for a layman, but his object had not been the acquisition of knowledge of merely theoretical value. Medical science had made marvelous progress during the last two generations in combating disease, chiefly in improved sanitation and in the knowledge of the nature of infection, but he thought that most of the great problems of non-infectious degenerative diseases of the latter third of life still remained unsolved. Great advances he felt reasonably certain would be made in the understanding of the endocrine glands during the next twenty-five years. He had been deeply interested in the splendid work that was being done in the animal genetics department of Edinburgh University and he was pleased that the biochemical department of McGill University was now actively cooperating with Edinburgh. He congratulated the University of Edinburgh on the part it was taking in the great work of the future. At a luncheon which followed the ceremony in the Library Hall of the Old University, Sir Thomas Holland mentioned that during the past two years Mr. Macaulay had given to the genetics department of the university contributions which amounted in all to £67,000; the university, he said, would endeavor to justify the confidence he had shown in its work.

The new buildings of the animal breeding research department of the University of Edinburgh are situated at West Mains Road. The original idea of this

department, conceived before the war, formed part of the plans of the development commissioners. After the war the plans were reconsidered, but shortage of money prevented development of the work on a large scale. In 1920 Dr. F. A. E. Crew, who was an assistant in the department of zoology of the university, was asked by Sir Edward Sharpey-Schafer, then chairman of the joint committee, to take charge of the embryo department, and a few rooms in the Old Infirmary buildings were devoted to its work. Here some sound scientific work was done. Studies on wool began in 1923, and studies on pigs in 1927, other subjects of agricultural importance being taken up later. In 1928, as the result of a gift of £30,000 from the International Education Board and of £10,000 from Lord Woolavington, the department was reorganized, and Dr. Crew was appointed to the newly founded chair of animal genetics. The buildings which have just been opened were then started. Their purpose is to provide facilities for work of a purely scientific nature which is expected to have an important effect upon agriculture in about fifteen or twenty years' time. At present inquiries are being undertaken into the inheritance of milk yield in cows, and into the ideal type of bacon-yielding pig.

THE GIANNINI FOUNDATION FOR AGRICULTURAL ECONOMICS AT THE UNIVERSITY OF CALIFORNIA

Giannini Hall, the gift of A. P. Giannini, built primarily to house the Giannini Foundation for Agricultural Economics, has been completed and is ready for occupancy by various divisions of the University of California College of Agriculture. At the present time, the Giannini Foundation will not require all the space provided by the four floors of the structure, and the college administrative offices, agricultural, extension, forestry and agricultural economics, will be housed there.

The building cost $500,000, and is the third of the agricultural group on the Berkeley campus. It is, in floor plan and shape, practically a duplication of Hilgard Hall. The building is 280 feet in length, 64 feet through the center, and the wings are 63 feet in width. In addition to university activities, cooperative offices such as the California Farm Bureau Federation, United States Forestry Experiment Station and the National Park Service will be housed in the building.

The director is Professor C. B. Hutchison, formerly director for Europe of the division of agricultural education of the International Education Board. Members of the staff in addition to Dr. Howard Ross Tolley, formerly chief of the bureau of agricultural economics for the U. S. Department of Agriculture, now professor of agricultural economics and assistant director of the foundation, include Dr. George M. Peterson, formerly of the agricultural economics staff of the U. S. Treasury Department, and Dr. J. M. Tinley, of the Department of Agriculture of the Union of South Africa. In September Professor Leland Spencer, of Cornell University, will assist the foundation in a special six-months' study of the milk surplus problem on which the local station is now working.

The station will attempt to put California agriculture and horticulture as a whole on a business basis, with the grower receiving the monetary return that his effort will produce. Through the Giannini Foundation, according to the announcement, it is expected that "the state will be in a position to take care of every phase of agriculture from the moment the farmer or grower starts in search of a suitable piece of land until his crops are placed on the tables of the ultimate consumers throughout the world."

STATE LANDS AND WILD LIFE OF WISCONSIN

The development and utilization of the land resources of Wisconsin to the end of giving each man, woman and child an environment for a life pattern containing all the attributes of growth, beauty and constructive living is the dominant purpose of the Wisconsin Land Inventory program, according to John S. Bordner, who is in charge of the inventory and who gave an account of the project at a recent meeting of the Wisconsin Academy of Sciences, Arts and Letters.

Those areas least occupied for agriculture and already being zoned for other uses are being first evaluated, in enumerating some of the things done to coordinate these various factors and to aid in the administration of land for diverse uses. The depth of lakes, the nature of their water, glacial action, sources of ground water, geographical distribution of plants, soil genetics and the trend in forest succession are being taken into account.

Through these and many other studies it is possible to show how many acres there are which have worthwhile timber growing on them and how many have worthless brush or are sodded over with prairie grasses, how much swamp there is which will produce timber and how much is worthless for anything except to grow Christmas trees for the children of Wisconsin or to continue as a habitat of rare and beautiful plants.

We also have one crew of two men determining the age and rate of growth of timber of different kinds and on different soils. From this study, it is possible to calculate just what each kind of forest will produce

annually, and to make a comparison of the yield and value of timber with growth. The distribution of wild life and the nature of their habitat are also mapped and tabulated in the same census.

The best land for private ownership, in growing timber and for summer homes, the areas adapted for use as parks, forest preserves, game preserves, boys' and girls' camps, or for whatever purpose the state may use them, are delineated so that they may be entered for the purpose of constructive use and not in a chaotic manner as land was entered in the pioneer days.

Throughout his address, Mr. Bordner emphasized the necessity of a life pattern that is not limited to the bounds of a man-made environment.

We are concerned, therefore, with the evaluation of land for diverse uses, to which land can be and should be put by our present and future population in Wisconsin. The evaluation of land for agricultural and forest, industrial and urban use is vital, but there are other uses just as vital, if our civilization is to reach beyond the immediate future.

THE FIFTH INTERNATIONAL BOTANICAL CONGRESS

The Fifth International Botanical Congress meets in Cambridge from August 16 to 23 under the presidency of Professor A. C. Seward, of the University of Cambridge. The honorary treasurer is Dr. A. B. Rendle, British Museum (Natural History), and Mr. F. T. Brooks, Botany School, Cambridge, and Dr. T. F. Chipp, Royal Botanic Gardens, Kew, are honorary secretaries.

According to the preliminary program, vice-presidents of the congress have been elected as follows:

Professor L. H. Bailey (Ithaca), Professor F. O. Bower (emeritus professor, Glasgow), Dr. J. I. Briquet (Geneva), Professor L. Buscalioni (Bologna), Professor R. H. Chodat (Geneva), Dr. L. Cockayne (Wellington, New Zealand), Professor P. A. Dangeard (Paris), Professor F. E. W. Elfving (Helsingfors), Professor H. G. A. Engler (Berlin-Dahlem), Professor Boris Fedtschenko (Leningrad), Professor Carl von Goebel (Munich), Professor V. Grégoire (Louvain), Professor R. A. Harper (New York), Professor B. Hayata (Tokyo), Professor J. Holmboe (Oslo), Professor H. O. Juel (Upsala), the President of the Linnean Society (London), Professor L. Mangin (Paris), Dr. E. D. Merrill (New York), Dr. S. G. Navashin (Moscow), Professor B. Němec (Prague), Sir David Prain (formerly director, Royal Botanic Gardens, Kew), Professor Christen Raunkiär (Copenhagen), the President of the Royal Horticultural Society (London), Professor C. Schröter (Zurich), Professor Hugo de Vries (Lunteren, Holland), Professor F. A. F. C. Went (Utrecht), Professor R. Wettstein-Westersheim (Vienna).

The presidents and vice-presidents of the sectional programs are as follows:

Bacteriology—President, Professor R. E. Buchanan, department of bacteriology, Iowa State College. *Vice-presidents,* Professor R. Burri (Liebefeld bei Bern, Switzerland), Professor H. R. Dean (Cambridge), Professor Orla Jensen (Copenhagen), Professor J. C. G. Ledingham (London), Dr. S. A. Waksman (New Brunswick, New Jersey).

Phytogeography and Ecology—President, Professor H. C. Cowles, University of Chicago. *Vice-presidents,* Professor L. Diels (Berlin-Dahlem), Professor K. Domin (Prague), Professor C. E. H. Ostenfeld (Copenhagen), Professor Pavillard (Montpellier), Dr. Ruebel (Zurich), Professor C. Skottsberg (Gothenburg), Professor W. Szafer (Cracow), Professor A. G. Tansley (Oxford).

Genetics and Cytology—President, Professor O. Rosenberg, Botanical Institute, Stockholm. *Vice-presidents,* Professor E. Baur (Müncheberg), Dr. A. F. Blakeslee (Cold Spring Harbor), Professor V. Grégoire (Louvain), Sir Daniel Hall (Merton, London), Professor H. Kihara (Kyoto), Professor B. Němec (Prague), Miss E. R. Saunders (Cambridge), Professor N. I. Vavilov (Leningrad), Professor O. Winge (Copenhagen).

Morphology (including Anatomy)—President, Professor J. C. Schoute, Groningen, Holland. *Vice-presidents,* Dr. A. Arber (Cambridge), Professor L. Buscalioni (Bologna), Professor C. J. Chamberlain (Chicago), Professor F. E. Fritch (London), Professor C. M. H. Glück (Heidelberg), Professor E. Küster (Giessen), Professor W. H. Lang (Manchester), Professor N. E. Svedelius (Upsala).

Mycology and Plant Pathology—President, Professor L. R. Jones, University of Wisconsin. *Vice-presidents,* Dr. O. Appel (Berlin-Dahlem), Professor A. H. R. Buller (Winnipeg), Dr. E. J. Butler (Kew), Dr. A. Jaczewski (Leningrad), Dr. R. Maire (Algiers).

Plant Physiology—President, Dr. F. F. Blackmann, Botany School, Cambridge. *Vice-presidents,* Dr. W. L. Balls (Cairo), Professor P. Boysen Jensen (Copenhagen), Professor V. H. Blackman (London), Professor E. Demoussy (Paris), Professor H. H. Dixon (Dublin), Professor L. Jost (Heidelberg), Professor M. Korczewski (Warsaw), Professor Lepeschkin (Tucson), Professor B. E. Livingston (Baltimore), Professor F. E. Lloyd (Montreal), Professor H. Lundegårdh (Stockholm), Professor N. Maximov (Leningrad), Professor W. J. V. Osterhout (New York), Professor W. Ruhland (Leipzig), Professor A. Ursprung (Fribourg, Switzerland), Professor F. A. F. C. Went (Utrecht).

Paleobotany—President, Dr. D. H. Scott, East Oakley House, Basingstoke, England. *Vice-presidents,* Professor E. W. Berry (Baltimore), Professor P. Bertrand (Lille), Professor W. Gothan (Berlin), Professor T. G. Halle (Stockholm), Dr. W. J. Jongmans (Heerlen), Professor Kraüsel (Frankfurt), Professor A. Renier (Brussels), Professor B. Sahni (Lucknow), Dr. G. R. Wieland (New Haven).

Taxonomy and Nomenclature—President, Professor Dr. L. Diels, Botanischer Garten und Botanisches Museum, Berlin-Dahlem. *Vice-presidents,* Dr. N. L. Brit-

ton (New York), Dr. E. De Wildeman (Brussels), Dr. R. E. Fries (Stockholm), Professor B. Hayata (Tokyo), Dr. A. W. Hill (Kew), Professor H. Lecomte (Paris), Dr. E. D. Merrill (New York), Professor R. Pampanini (Florence), Professor Hans Schinz (Zurich), Dr. O. Stapf (Kew), Professor R. Wettstein-Westersheim (Vienna).

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The draft of the program for the meeting of the British Association at Bristol from September 3 to 10 has now been completed and is summarized in the London *Times*. There will again be some 300 papers. The botanical section's addresses are unusually numerous, but the president this year is Professor F. O. Bower, emeritus professor of botany in the University of Glasgow. A number of the delegates to the International Congress of Botanists at Cambridge will go on afterwards to this meeting.

The president's address this year will also follow the modern rather than the older style. The model which passed in review the advancement made in every department of science will not be adopted by Professor Bower. His address will be purely botanical and will consist largely of a statement concerning his own work, and his subject will be "Size and Form in Plants."

It is interesting to note, according to the *Times*, that at a meeting in Bristol in 1898 Sir William Crookes prophesied a world-scarcity of wheat unless agriculture sought the aid of chemistry. This year one of the subjects of the agricultural section will be the relation of nitrogen to our food supply.

A meeting in Bristol is also a natural stimulus to the archeological, geological and engineering interests. There will be lectures on Roman remains in Gloucestershire and on geological formations such as those at Cheddar. Modern engineering has an important representative in the Bristol Aeroplane Company. There will be papers on recent progress in air-cooled aero-engine development and on the present position of the high-speed heavy oil engine. The latter will be associated with another lecture, by Lieutenant-Colonel V. O. Richmond, the designer of the airship R 101, which is driven by heavy oil engines. There will also be lectures on the construction of R 100 by Mr. B. N. Wallis and on the Graf Zeppelin by Herr W. E. Doerr, and films of all three airships will be shown.

Much attention will be given by the section of mathematical and physical sciences to wireless problems. A discussion on the meteorological relations of atmospherics will be shared by Dr. R. A. Watson-Watt, Professor E. V. Appleton and Mr. M. A. Giblett. Professor Appleton will also read a paper on wireless echoes and wireless demonstrations will be given by the B.B.C. Town-planning will be fully discussed by the geography section and the position of the British dyestuffs industry will be discussed in the chemistry section by Professor G. T. Morgan, Sir William Pope, Professor J. F. Thorpe, Professor A. G. Green and others.

The public lectures will be more numerous than usual. Bath, Cheltenham, Gloucester, Devizes and Chard, for instance, have all asked for lectures on economic subjects. Sir Josiah Stamp will lecture at Bath on the price level and scientific control. Weston-super-Mare, having chosen a health subject, will hear Professor Winifred Cullis on "Breathing under Difficulties"; Swindon will have a lecture on some branch of aeroplane engineering by Wing Commander Cave-Brown-Cave, and Cirencester will have a description of Gloucestershire excavations by Dr. R. E. Mortimer Wheeler.

One of the subjects for Bristol is the bearing of research on the improved production of apples. Sir Daniel Hall will give this lecture on market day. Sir Arthur Keith will speak on the contribution of Dr. John Beddoe, the Bristol anthropologist, to modern anthropology. East African archeology and astronomy will be the other subjects at Bristol.

The centenary meeting of the British Association will be held next year in London, probably with General Smuts as president. It will take place at the end instead of the beginning of September, and its chief meetings will probably be held at the Central Hall, Westminster.

SCIENTIFIC NOTES AND NEWS

The eightieth birthday of Dr. William H. Welch was celebrated in the Kitasato Institute for Infectious Diseases in Tokyo on April 8. The main address was made by Dr. Kitajima; other speakers were Dr. Madsen, of Copenhagen; Professor Kofoid, of the University of California, and Dr. Kitasato.

A dinner was recently given in London by the Physiological Society in honor of the eightieth birthday of Sir Edward Sharpey-Schafer, professor of physiology at the University of Edinburgh.

In honor of Dr. George F. Arps, professor of psychology and dean of the College of Education of the Ohio State University, a dinner was given on the tenth anniversary of his deanship. Dr. W. O. Thompson, president emeritus; Julius F. Stone, chairman of

the board of trustees; Dr. Boyd H. Bode, and Professor Wilbur H. Siebert paid tribute to him.

AT a recent meeting of the council of the French Society of Industrial Chemistry, Professor Marston Taylor Bogert, of Columbia University, was elected to honorary membership.

PROFESSOR SIGMUND FREUD, psychiatrist, of Vienna, has been awarded the Goethe prize for scientific and literary distinction.

SIR CHARLES SHERRINGTON, Waynflete professor of physiology in the University of Oxford, and Dr. J. A. Arkwright, honorary bacteriologist to the Lister Institute of Preventive Medicine, have been appointed members of the British Medical Research Council in succession to Sir Frederick Hopkins and Sir Charles Martin.

DR. HUGH P. BAKER, who served as the first dean of the New York State College of Forestry at Syracuse University from 1912 to 1920, has been re-elected to that office by the board of trustees. He succeeds the late Dean Franklin Moon. Dr. Baker left Syracuse University to accept a position as executive secretary of the American Paper and Pulp Association. Two years ago he became manager of the department of trade association service in the U. S. Chamber of Commerce. Before going to Syracuse the first time he was head of the departments of forestry of the Pennsylvania State College and of the Iowa State College. Professor Nelson C. Brown, acting dean of the college since Dr. Moon's death, was given a vote of appreciation for his service by the trustees. He will remain in the college in an administrative capacity.

DR. ALLAN WILSON HOBBS, professor of applied mathematics and a member of the faculty for thirteen years, has been appointed dean of the College of Liberal Arts of the University of North Carolina, succeeding Dr. Addison Hibbard, who resigned in May to accept a position at Northwestern University.

UNDER the Bosch benefaction at Sydney University the following appointments have been made: to the chair of surgery, Dr. Harold Dew, practicing surgeon of Melbourne; to the chair of bacteriology, Dr. Hedley Duncan Wright, reader in bacteriology in the University of London and assistant editor of the *Journal of Pathology and Bacteriology,* and to the chair of medicine, Dr. Charles George Lambie, lecturer in medicine at the University of Edinburgh.

DEAN ROSCOE POUND, of the Harvard Law School, has been nominated by the British group for judge of the Permanent Court of Arbitration. The Australian group also nominated Dean Pound to fill the unexpired term of Mr. Charles Evans Hughes.

THE Secretary of State for Scotland has appointed Mr. A. Froude to be registrar-general for Scotland, in succession to Dr. James Craufurd Dunlop, whose retirement under the age limit will take effect on September 3.

THE American Engineering Council has announced the appointment of six engineers to an advisory committee which, under Dr. George K. Burgess, director of the United States Bureau of Standards, will plan the design and equipment of the National Hydraulic Research Laboratory. Two members of the committee—John R. Freeman, of Providence, and William B. Gregory, professor of experimental engineering at Tulane University—will devote several months to the study of hydraulic laboratories in Europe. The other members of the advisory committee are Sherman M. Woodward, professor of mechanics and hydraulics at the University of Iowa; Lewis F. Moody, consulting engineer for Cramp-Morris Industrials, Inc.; Ely C. Hutchinson, editor of *Power,* and Blake R. Vanleer, assistant secretary of the American Engineering Council.

THE National Tuberculosis Association announces the appointment of three research fellows for the academic year 1930–31. The successful candidates were selected from a large number applying from all parts of the country. Those to whom the awards were made are: Alvin E. Belden, M.D., Lancaster, Pennsylvania; William F. Lawrence, C.P.H., Portsmouth, Virginia, and Edna E. Nicholson, A.B., Ann Arbor, Michigan.

THE trustees of the Ramsay Memorial Fellowships have made the following awards of new fellowships for the session 1930–31: Mr. W. R. Angus, a fellowship of £300, tenable for two years, at University College, London; Dr. K. Krishnamurti, a fellowship of £300, tenable for one year, at University College, London; Dr. James Bell, a Glasgow fellowship of £300, tenable for two years, at University College, London, and Dr. A. Girardet, a Swiss fellowship of £300, tenable for one year, at the University of Edinburgh. The trustees have renewed the following fellowships for the same session: Dr. H. Erdtman (Swedish fellow), University College, London; Dr. A. Klinkenberg (Netherland fellow), University of Cambridge; Professor Y. Nagai (Japanese fellow), University College, London, and Dr. Lloyd M. Pidgeon (Canadian fellow), University of Oxford.

THE trustees of the Beit Fellowships for Scientific Research, founded and endowed in 1913 by Sir Otto Beit, have awarded fellowships, tenable at the Imperial College of Science and Technology, South Kensington, for the two years 1930–32, of the value of £250 a year each, to Mr. Bernard William Brad-

ford, for research upon the electrical condition of hot metallic surfaces when promoting the combustion of carbonic oxide; to Mr. George Maxwell Richardson, for research into the further application of electrometric methods and theory to the study of problems of biological interest, and to Mr. Geoffrey Herbert Cheesman, for research on the electron distribution and structure of the halogen oxides.

Dr. George Grant MacCurdy, of Yale University, honorary collaborator in the anthropological department of the U. S. National Museum, has been appointed American delegate to the eleventh International Congress of Prehistoric Anthropology and Archeology at Coimba, Portugal. Dr. MacCurdy will also be the American delegate to the fourth session of the International Institute of Anthropology meeting simultaneously at Coimba.

Dr. A. S. Hitchcock sailed for Europe on August 1 to attend the International Botanical Congress at Cambridge. He attends the congress as delegate from the U. S. Department of Agriculture, the Botanical Society of America and the Botanical Society of Washington.

Dr. C. J. Wiggers represented Western Reserve University at the medical meetings connected with the recent celebration of the one hundredth anniversary of Belgian independence in Brussels.

Mr. Rudyard Boulton, assistant curator of ornithology at the Carnegie Museum of Pittsburgh, an expert in the collection and preservation of insects, and Mrs. Boulton, sailed on August 5 for England. They will accompany Mr. and Mrs. Ralph Pulitzer in an expedition to southeastern Angola, Africa and down the Okavango River, where it is hoped to find specimens of the white rhinoceros. The specimens collected by the expedition will go to the Carnegie Museum.

The Scarritt Patagonian expedition to collect fossil mammals under the leadership of Dr. George Gaylord Simpson, of the staff of the American Museum of Natural History, sailed for Buenos Aires on August 8.

Dr. Clyde Fisher, of the American Museum of Natural History, has visited Iceland on a mission for the New York Bird and Tree Club, of which he is president. He will also visit Norway, Denmark and Sweden, where he expects to take photographs for the educational work of the museum. Dr. Fisher took with him as a gift from the New York Bird and Tree Club to the people of Iceland several crates of small American evergreen trees, as well as the promise of seedlings to be sent in the coming fall and spring. These were presented at the millennial celebration of the founding of the government of Iceland.

Natural History reports that Dr. James P. Chapin, associate curator of birds of the eastern hemisphere at the American Museum, is now on a collecting trip in the Belgian Congo, which is made possible through a fund established by Mrs. Dwight Arven Jones. Dr. Chapin attended the seventh International Ornithological Congress at Amsterdam with Dr. Frank M. Chapman, and from there went to Brussels to complete arrangements for his journey to the Belgian Congo. Dr. Chapin is accompanied by Franklin Edson, 3d, a representative of the department of mammalogy at the American Museum, who had volunteered to assist him. The material collected will make possible a group showing the bird life of an African tropical forest and will be a companion group to one depicting the bird life of the plains.

A series of Hertzein lectures was given under the auspices of the University of California and Stanford University in San Francisco on August 7, 8 and 9, by Dr. Charles Singer, of the University of London. The titles of the separate lectures were: "Medieval and Modern Medicine" Part I and Part II, and "The Scientific Works of Leonardo da Vinci."

The annual meeting of the American Astronomical Society will be held in Chicago from September 3 to 5.

The fourth International Congress for Individual Psychology will be held in Berlin from September 25 to 28. It will open with an address by Dr. Alfred Adler.

The thirteenth International Congress of Hydrology, Climatology and Medical Geology will be held at Lisbon from October 15 to 23. During the congress visits will be paid to the more important towns and spas of Portugal, and an excursion will be made to the Azores and Madeira. Further information can be obtained from the Faculty of Medicine, Lisbon.

The council of the Royal Institute of Public Health of Great Britain has accepted an invitation from the German Government, the municipality of the city of Frankfurt and the university of that city to hold its congress in May, 1931, in Frankfurt. The Marquess of Reading will preside.

It is reported in *Nature* that the fifth ordinary general meeting of the Ross Institute and Hospital for Tropical Diseases was held on July 9. The Chairman, Sir Charles McLeod, reviewed the work of the year. Sir Ronald Ross, Sir William Simpson, Sir Aldo Castellani and D. Shaw-Mackenzie have continued their researches, and a new department in charge of Sir Malcolm Watson has been created to deal with malaria and its problems. Short courses for planters on malaria control have been held and much propaganda work on this subject has been prosecuted.

The institute has no endowment fund except a few hundred pounds and is dependent for its income upon contributions from companies and donations and subscriptions, an increase in which is appealed for.

Because of a year's delay in obtaining radium for the Marie Curie Radium Institute of Warsaw, for which Mme. Curie was given $50,000 in 1929 by a group of Americans, the hospital will not be able to open its doors until December. The delay is said to have had its advantages, however, for the interest on the money will be sufficient to purchase platinum screens for the radium when it becomes available.

Major-General Merritte W. Ireland, Medical Corps, U. S. Army, states that the "Index Catalogue of the Surgeon General's Library" is to be continued, after consideration of replies to his recent letter of inquiry. Ninety per cent. of institutions and organizations addressed expressed an earnest desire for a continuation of the catalogue. A new series will be started after the completion of the present, or third, series.

An Associated Press dispatch reports that Premier Mussolini, on receiving plans for the dental clinic for which Mr. George Eastman, of Rochester, N. Y., gave $1,000,000, ordered the opening for October 28, 1932, the tenth anniversary of the Fascist march on Rome.

Christian Michelsen, formerly prime minister of Norway, has instituted a fund of 5,500,000 crowns for scientific research. The statutes of the institute to which the funds are to be given contain a provision to the effect that the board may grant yearly contributions to Norwegians interested in research work.

A decision was handed down by the Court of Claims on June 16, 1930, in a test suit brought by the Cosmos Club, Washington, which holds that it is not a social, sporting or athletic club within the meaning of the Internal Revenue Act providing for taxes on dues and initiation fees of members of a social, sporting or athletic club and that therefore the ten per cent. tax on dues and initiation fees of members which heretofore has been exacted should be returned by the government.

A decision resulting from the refusal of Harvard University to accept a gift in a will to endow courses for instruction in eugenics has been handed down by the Supreme Court of Pennsylvania in the cases of Mears' Estate, in which the court held that the gift was one which must be deemed to be for a charitable use, and that since the specific purpose had failed because of Harvard's rejection of the gift, the court would name another medical school to carry out the charitable intent of the testator.

DISCUSSION

EARLY DEFINITIONS OF THE MATHEMATICAL TERM ABSTRACT GROUP

While science is international it is always of some interest to consider the question in what country certain fundamental ideas were first published. For instance, it is well known that English and German writers were inclined for many years to claim for their own respective countries the discovery of the calculus under the leadership of I. Newton and G. W. Leibnitz, respectively. Hence it is of some interest to note here that the honor of the discovery of abstract group theory seems also to be shared by these two countries, although up to the present time it has been customary to credit German writers alone, especially L. Kronecker (1870) and H. Weber (1882 and 1893), for the earliest publications of sets of postulates relating to abstract groups. Sometimes G. Frobenius (1887) has also been thus credited.

This credit entails, however, a striking anomaly in the history of group theory since it is universally admitted that the English writer A. Cayley was the first to publish a complete determination of the possible abstract groups of all the orders which do not exceed certain small numbers, publishing this determination for the orders less than 8 in 1854 and for order 8 in 1859. It is obviously impossible to determine rigorously all the abstract groups of a given order without employing a definition of the technical term abstract group, and such a definition implies a set of postulates. What is perhaps a still more striking anomaly in the history of group theory is the fact that A. Cayley is commonly given credit for the earliest proof (1854) of the fundamental theorem that every abstract group of finite order can be represented as a regular substitution group, and such a proof seems to imply a set of group postulates.

This proof results directly from the well-known group table which was used by A. Cayley in 1854, and hence it seems to imply that a set of group postulates was known in England at that time. As a matter of fact it is not difficult to see that A. Cayley used here substantially the same set of postulates for a finite group as the one which was published later by H. Weber in the *Mathematische Annalen,* volume 20 (1882), page 302. It is true that A. Cayley's postulates were not as clearly formulated as some of those which were published later and that he restricted his attention to groups of finite order. On the other hand, the set of postulates which was published by L. Kronecker in 1870 and which has been widely quoted

as the earliest set of abstract group postulates is not only restricted to groups of finite order but also to commutative groups of such orders.

One of the most fundamental postulates relating to group theory is that the elements of a group must obey the associative law but not necessarily the commutative law when they are combined. This postulate is explicitly stated in the usual form by A. Cayley in the article under consideration. The postulate that the product of two elements of a group is equal to an element thereof is also stated here in the usual form. As a third postulate A. Cayley assumes here that if $axb = ayb$, where a and b are two elements of the group, then $x = y$ if one of them is an element of the group. As he assumed that every integral power of each element of the group is in the group he could readily prove that the identity is also therein, and hence a group postulate commonly given now results from his third postulate noted above by letting a and b represent successively the identity.

The main object of the present note is to exhibit some of the reasons for saying that the earliest set of group postulates was due to A. Cayley and thus to make the historical statements relating to the early developments of abstract group theory appear more harmonious. It is commonly said that the earliest treatise on abstract group theory is the "Theory of Groups of Finite Order," by W. Burnside, 1897. This would seem to imply that as far as group theory is concerned the tendency towards the abstract was more marked in England than in the other European countries. At any rate, it is interesting to note that notwithstanding the great importance of the groups of infinite order the earliest definitions of abstract groups both in England and in continental Europe were restricted to groups of finite order.

It may be desirable to add to the above a brief explanation of the technical term abstract group. This term implies not only that no attention is paid to the applications in the theory of these groups but also that no properties of their elements are considered therein except those relating to the laws which these elements obey when they are combined. Such a group can therefore not exist without its corresponding set of postulates. It is interesting to note that while a large number of different sets of postulates has been proposed these sets have nearly always been equivalent and differed from each other only as regards simplicity or redundancy. Hence no serious diversity in developments has as yet arisen on account of the adoption of different definitions of the term group. It is true that the term group is also sometimes used in the mathematical literature with such a general meaning that no extensive theory can as yet be based thereon. This is done, for instance, in the *Encyclopédie des Sciences Mathématiques*, tome 1, volume 2, page 243. The preceding remarks have obviously no contact with this definition.

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SELENITE FRAGMENTS OR CRYSTALS AS CRITERIA OF WIND ACTION

STUDENTS of geomorphology are naturally interested in and seeking for criteria which may be used to interpret the origin and history of land forms. Various criteria of wind action have been and are now being used by students of geomorphology to establish the effectiveness of the wind as the chief agent in producing and destroying the land forms of arid regions. Among such criteria may be mentioned the following: wind-worn stones, collar-studs, vermicular or arabesque limestones, stone lace, stone lattice, lag gravels or desert pavements, pedestal rocks, niches and caverns, jardang or sphinx rocks, dunes, ridge and hollow type of topography, depressions or lake basins, etc. It is not the purpose of this short paper to discuss the merits of these phenomena as criteria of wind action, but it is sufficient to say that some of them, such as pedestal rocks, niches, vermicular limestones, stone lace and stone lattice, have lost much of their critical value as a result of detailed studies.[1]

Experiments performed by Schoewe at Harvard University last winter on the formation of dreikanter or ventifacts by means of an artificial sandblast have suggested a new criterion which may be used to indicate the presence or absence of wind action. In the course of these experiments, several substances were introduced into the sandblast for the purpose of studying the rate and also the general effect of abrasion by sand. Bright, glistening cleavage fragments of selenite were immediately frosted. The effect took place so rapidly that it is inconceivable that bright selenite fragments could exist in an area having any effective action by windblown sand. In arid regions the optimum condition obviously exists for the formation, preservation and accumulation of selenite crystals or cleavage fragments at the surface.

Gypsum is soluble in rain water, as noted by Lahee,[2] who proved that granular gypsum was dissolved at the rate of one inch (25.4 mm) in twenty-eight years in Stonewall County, Texas, where the rainfall is twenty-three inches (584.2 mm) a year.

[1] Kirk Bryan, "Pedestal Rocks in the Arid Southwest," U. S. Geol. Survey, Bull. 760, 1923, pp. 1–11; "Pedestal Rocks in Stream Channels," U. S. Geol. Survey, Bull. 760, 1923, pp. 123–128; "Pedestal Rocks Formed by Differential Erosion," U. S. Geol. Survey, Bull. 790, 1926, pp. 1–19; "Niches and Other Cavities in Sandstone at Chaco Canyon, New Mexico," *Zeitschr. f. Geomorphologie*, 3: 125–140, 1928; B. G. Esher, "Über des Reliefs auf den sogenannten Rillensteinen," *Geol. Rundschau*, 4: 1–7, 1913.

[2] F. H. Lahee, "The Rate of Solution of Gypsum," *Jour. Geol.*, 33: 548–549, 1925.

Most areas in the United States characterized by selenite fragments have annual rainfalls of from five to fifteen inches (125 to 375 mm). Obviously none of the fragments can lie on the surface for any great number of years and still remain bright and glistening, since they will be gradually dulled by solution. Even this short time is long compared to the few minutes necessary for frosting by the sandblast.

Hence it is safe to conclude that bright, glistening fragments or crystals signify an absence of effective wind action. The presence of these fragments of selenite in the vicinity of niches and pedestal rocks, such as occur at so many localities in the Cretaceous, Jurassic and Triassic areas of Western United States, might be used as indicative of the general absence of effective wind scour.

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ARE PLANETS RARE?

THE latest statement of Professor Arthur H. Compton as reported in the *Literary Digest* under the title, "Science's New View of Evolution," should not be allowed to pass without comment.

That a directive intelligence is evident in the universe is undoubtedly held by a great majority of scientists; but that the new principle of uncertainty "which disputes the uniformity of the physical world" supports this view many of us might be disposed to question. The unity of the universe, as shown by the absolute unchangeableness of natural law, has been held from the time of Newton to be one of the strongest arguments for the existence of God.

Leaving this aside, however, I seriously question Professor Compton's statement in regard to the rare occurrence of planets. He says, "Though astronomers tell us that there are millions of millions of stars in the sky, a planet is a very rare occurrence, and a planet on which life can exist is even more rare."

No telescope, unfortunately, will show us the planets of other suns. Our views on the subject must be based on what we find in our own system. Here we have eight major planets revolving about the sun, and six of these have satellites forming miniature solar systems. Does this look as though such systems were a freak of nature—a rare occurrence? That double stars have planetary systems may be doubtful, but there is absolutely no reason for the assumption that the formation of families of attendant worlds may not be the ordinary course of evolution for the single stars.

As for life on these worlds, we have in our system one out of eight that is fitted for the support of life, and another, Venus, which may be habitable. Why should the proportion be different throughout the universe? Surely the success of the noble experiment of life on the earth has not been so notable that we may not hope for better results elsewhere.

JERMAIN G. PORTER
THE CINCINNATI OBSERVATORY

VIABILITY IN EGGS OF AEDES CAMPESTRIS DYAR AND KNAB (CULICIDAE)

ON July 12, 1928, adults of *Aedes campestris* were caught as they came to feed, allowed to engorge and then isolated over water. Four days later eggs were laid. These were placed in pond water in tightly stoppered glass vials and stored in a cold chamber in which the temperature fluctuated between 0° and 10° C. In March, 1930—twenty months after they were laid—the vials were unstoppered and placed at 22° C. Within twelve hours about 25 per cent. of the eggs hatched, and during the ensuing five days several additional eggs hatched into healthy, vigorous larvae, which duly matured.

Aedes campestris constitutes one of the dominant species in the plains areas in Montana, and this remarkable viability of the eggs merely complicates the problem of efficient control.

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THE MITOSIS FOUND IN HYDRA

THE endoderm and ectoderm of hydra each present epitheliomuscular and interstitial cells. The mitosis occurring in epitheliomuscular cells is quite typical for a dividing metazoon cell. The interstitial cells, however, present a mitosis that is more primitive. The mitotic figure of an interstitial cell lacks asters, centrosomes and centrioles, despite the fact that spindle fibers converge sharply at the poles. Moreover, the primitive condition of the mitosis of the interstitial cell is seen in the fact that the prophases appear within the original nuclear area. A marked characteristic of the mitosis of the interstitial cells is that its spindle fibers persist even after the daughter nuclear membranes have been formed. The daughter cells themselves are linked together by a persistent spindle. This vestigial spindle eventually disappears and the daughter interstitial cells lie contiguous but free.

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SCIENTIFIC BOOKS

Four Centuries of Medical History in Canada, and a Sketch of the Medical History of Newfoundland. By John J. Heagerty, M.D., D.P.H., with a preface by A. G. Doughty, C.M.G., F.R.S.C. 2 vols. 8°. Toronto, Macmillan Co. of Canada, Ltd., 1928.

As the Dominion archivist points out in his preface, the outstanding merit of this work is that the author, wherever possible, "allows contemporaries to tell their stories for themselves." It is a thoroughly documented history, based primarily upon findings in the Public Archives of Quebec, Ottawa and Montreal; while Jacques Cartier, Champlain and the Jesuit fathers tell, in their own language, of the effects of smallpox, yellow fever, plague, typhus fever, leprosy, cholera, influenza and other devastating diseases upon the immigrant population. For this purpose, the Canadian records are singularly complete, from the *Jesuit Records* and those of the sixteenth century explorers, down to the latest government documents. Although the author has modestly aimed to produce a reference work rather than a continuous story, his opening chapters on the outstanding diseases affecting the infant colony make very good reading, of particular value to the historian of the future. For it is just the effect of disease upon the course of history which has been most neglected by secular historians. Both Thucydides and Lucretius stress the social significance of the plague of Athens and Livy the effects of epidemic diseases upon Roman military campaigns; but the subject is ignored by Wells, nor does it receive any attention in the 20 large volumes of the "Cambridge History, Ancient and Modern." Dr. Heagerty's opening chapters show that communicable diseases kept down the immigrant population of the New World as effectively as in the older countries of sixteenth century Europe. His documentation of the theme is as thoroughgoing as that of Creighton ("History of Epidemics in Britain") and is a model for all future historians of medical developments in individual countries or nations. As Gjerset and Hektoen found in the Wisconsin records, the successive shiploads of immigrants were as a thin red line on the edge of battle until the arrival of a sufficient number of *bona fide* physicians to look after them. The pioneer physicians in the various provinces of Canada form the subject-matter of Part 2 of the first volume.

Of these Deschamps, Maître Estienne, Daniel Hay, Louis Hébert, Bonnerme, Duchesne, André Daniel, Robert Giffard, René Goupil, Jean Madry, Jourdain Lajus, Thimothée Roussel, Michael Sarrazin, the leading surgeon of seventeenth century Canada, and J. F. Gualthier, discoverer of the wintergreen plant (*Gualtheria procumbens*), are notable in the early history of Quebec; John Gilchrist, James MacAulay, Christopher Widmer, Grant Powell, John Rolph, William Dunlop in Ontario; Abraham Gesner in Nova Scotia; Roderick MacDonald and Benjamin de St. Croix in Prince Edward Island; Desmarets, Curtis Bird and Sir John Schultz in the North West Territories; Tolmie and Helmcken in British Columbia; Jonathan Ogden, Francis Bradshaw and William Carson in Newfoundland.

The names of 22 French surgeons and apothecaries are found in the Quebec registers of 1629–63 and Heagerty lists the names of 42 French physicians practicing in Montreal during 1648–1760. As Carlyle said, Frederick's campaigns decided incidentally whether the upper half of the Western hemisphere was to be French or Anglo-Saxon. The first volume winds up with chapters on the earlier status of medical and surgical practice in Canada, the medical journals, the medical societies, the beginnings of military medicine and the development of public health departments in the different provinces. Bleeding, purging and sweating constituted the staples of medical practice; diphtheria was continuously epidemic up to the introduction of antitoxin (1894) and surgery was primitive prior to the discoveries of anesthesia (1847) and antisepsis (1867–77). Specialism began when Dr. Richard Andrews Reeve commenced practice in ophthalmology and otology in Toronto (1867). The first medical periodicals were the *Journal de médecine de Quebec* (January, 1826) and the *Montreal Medical Gazette* (1845). The first medical society was the Quebec Medical Society (1826). The earliest known Canadian medical publication is the *Direction pour la guérison du mal de la Baie St. Paul* (Quebec, 1785), a 16-page pamphlet in the Library of the Provincial Archives of Quebec.

The second volume is taken up with such public health developments as prevention of tuberculosis, nursing orders, Red Cross, mental and social hygiene, the Grenfell Mission, quarantine, vital statistics, legislation, with terminal chapters on the medical schools and hospitals. The first public health laws of Quebec were enacted in 1707. The first hospital was the Hôtel Dieu of Quebec (1639). Montreal General Hospital was founded in 1818, and around it grew up the earliest establishment for medical education, the Medical Faculty of McGill University (1822), the story of which has been told at length by Maude Abbott (1902). The first provision for organized care of the insane was the establishment of an asylum in a manor-house at Beaufort (1845). An appendix on the history of medicine in Newfoundland, an extensive bibliography and an index of contents close the work, which is profusely illustrated.

F. H. Garrison

Welch Medical Library, Baltimore

SOCIETIES AND MEETINGS

THE ILLINOIS ACADEMY OF SCIENCE

THE Illinois Academy of Science held its twenty-third annual meeting at the University of Illinois at Urbana on May 2 and 3, 1930. The meeting was held in conjunction with the quarter-centennial celebration of the Illinois State Geological Survey, and was the best attended in the history of the organization. Over 600 were present at the various sectional meetings. As the result of an intensive membership campaign, about 250 new members were added, bringing the total membership to nearly 1,000. These new memberships include 23 new high-school science clubs which have become affiliated with the state organization.

At the business sessions of the academy a decision was reached to create a Hall of Fame for Illinois scientists. The committee selected to take charge of this project includes five members, all of whom are past presidents of the academy: Dr. M. M. Leighton, chief of the State Geological Survey, *chairman;* Dr. William A. Noyes, professor emeritus of chemistry, University of Illinois; Dr. H. J. Van Cleave, professor of zoology, University of Illinois; Dr. Henry C. Cowles, chairman of the department of botany, University of Chicago, and Dr. U. S. Grant, chairman of the department of geology, Northwestern University.

Other officers and committees elected to serve for 1930–1931 are as follows:

President, Fred R. Jelliff, the *Daily Register-Mail,* Galesburg.

First vice-president, William P. Hayes, University of Illinois.

Second vice-president, Arthur L. Epstein, Peoria.

Secretary, F. M. Fryxell, Augustana College.

Treasurer, George D. Fuller, University of Chicago.

Librarian, A. R. Crook, State Museum, Springfield.

Delegate to the American Association for the Advancement of Science, A. C. Walton, Knox College.

Delegates to the Conservation Council of Chicago, W. G. Waterman, Northwestern University, Evanston; V. O. Graham, University of Chicago.

F. M. FRYXELL,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID METHOD FOR STAINING SECTIONS OF THE SPINAL CORD AND BRAIN-STEM

SECTIONS used for class teaching of the central nervous system are commonly prepared by rather elaborate and time-consuming technique, even so-called rapid methods being relatively complicated.

In searching for a substitute to supply each student with a complete series to assure him a chance to examine every important feature, the writer found an exceptionally quick method of procedure, with the added advantage over the more complicated techniques that it furnishes a remarkably ready and direct correlation between gross and microscopic structure, and makes complete series unnecessary, though of course these are not superseded entirely.

Using this method students can select pieces of the cord or brain-stem which have been hardened a few days or longer, or which come from the cadaver, and cut through any desired region with a safety razor blade, to show in a few minutes the microscopic details of the parts cut. Thus one secures the readiest comparison and understanding of the buried microscopic structures and connections forming the basis of surface relief. This is one of the difficult problems of beginners, and it is most helpful for them to be able to repeat such studies, at will, through different levels.

Naturally the material of a dissecting room varies, and the sharpest pictures will come from the best fixed bodies; but there are advantages in having pathological conditions shown in some sections. It is also valuable to be able to demonstrate the results of specific lesions, as ascending or descending degeneration of various tracts, in subjects which have been examined for other correlated pathology.

To lay open, at will, and demonstrate quickly the finer internal relations of nuclei and connections of any cranial nerve or other special structure of the medulla prominent in surface views is a helpful preliminary to later more detailed study by other methods.

The method can be also used in testing conclusions gathered from symptoms and autopsy, without loss of time and sacrifice of material, since it marks out degenerate posterior funiculi or crossed and direct cerebrospinal tracts or other pathological features. I have not investigated this phase extensively beyond making tests of the practicability of such diagnosis. For the opportunity of making these tests on cords with known histories I have to thank Dr. N. W. Winkleman, of the department of neurology in the Medical School of the University of Pennsylvania.

The method here outlined is an adaptation of the "Rapid Iron Hematoxylin Technique" which was published by Dr. E. C. Cole, of Williams College, in

SCIENCE, November 5, 1926.[1] My own modifications of the technique are in connection with the special material used and the exceptional use of quite thick sections, together with the study of these in a strong reflected surface light, rather than by transmitted light from below through cleared sections. For special purposes it is possible of course to stain relatively thin frozen sections by this technique, and clear and study as usual, but the quicker method with thick sections seems preferable for the objects of this study.

The following steps of procedure are recommended.

(1) Material: Pieces of cord and brain-stem from cadavera in which formalin has been introduced beneath the dura and allowed to stand are most favorable. Some specimens which were evidently embalmed late showed fatty degeneration more or less markedly. Pieces of cord which have remained *in situ* during the dissection of the body can be removed to alcohol and put through this method from 95 per cent. alcohol. Fresh cords make excellent material after thorough hardening, poorly fixed and hardened specimens crumbling on cutting. Old bottled formalin or alcoholic material may often be used with good effect.

(2) Cutting: Sections should be smoothly cut freehand, one or more millimeters thick, with a sharp, flat, thin razor blade. The thicker sections are preferable, though frozen sections of about 100 micra which do not curl or tear are quite usable. As has been said, it is feasible to cut thinner frozen sections, double stain, clear and mount in balsam, but these have restricted usefulness.

(3) Mordanting: Sections should stand in 95 per cent. alcohol for at least 5 minutes, then be transferred to Cole's mordant made as follows: 50 per cent. alcohol, 20 cc; ferric chloride, 1 grm; glacial acetic acid, 2 cc. Sections remain in this mordant for at least 5 minutes. For some material this process of mordanting is sufficient when prolonged till the details of structure have developed out sharply. The sections can then be removed to alcohol and studied without further treatment, but most material gives better results when stained as follows.

(4) Staining: First prepare Cole's "stock hematoxylin solution" as follows: absolute alcohol, 20 cc; sodium hydrosulphite (same as sod. bisulfite), 0.2 grm; distilled water, 5 drops; hematoxylin crystals, 1 grm. Use light brown crystals, not dark crystals of hematoxylin. A useful discussion of the staining will be found in Dr. Cole's original article.

Now add 5 drops of this just described stock solution to 10 drops of tap-water, and follow this with 1 drop of ammonium hydroxide. Before using let this mixture stand to ripen for 30 seconds. Now add 5 cc of 95 per cent. alcohol to this ripened staining solution and flood the section (which has been taken from its alcoholic bath) to cover its smooth-cut surface. Allow the stain to act for at least 5 minutes. This over-stains and must be differentiated.

(5) Differentiation: This should be accomplished by destaining through the action of 0.4 per cent. hydrochloric acid. The microscopic details of the gray matter can be thus brought out sharply in contrast to a darker background. It is sometimes well to stroke the surface with cotton or lens paper to remove sediment deposited from the stain. When sharp definition is obtained rinse off in slightly alkaline 95 per cent. alcohol and study by strong reflected light.

A very instructive picture of the grosser features and relations of the gray figure, compared in different regions, is secured by diluting the stain and using it briefly without differentiation. In this case the gray figure and septa stand out black against the lighter matter of the funiculi, but little detail is shown within the gray figure.

Dr. Cole's original paper contains interesting discussion of the various applications and problems connected with the use of his stain which does not seem to be known as well as it deserves.

(6) Lighting: Reflected light of strong intensity should be used, preferably concentrated on the surface of the section by a condensing lens. Under this lighting the section should be studied with a hand lens, binocular spectacles or a low power 48 millimeter objective on a compound microscope.

Of course the mordant and stock solutions will be prepared in advance for class work, and each student will follow the technique in watch-glasses and begin study of the specimens in a few minutes. Once stained, sections may be kept in alcohol for later examination.

This paper was finished at the Wistar Institute. I take pleasure in here thanking the director and staff of the institute for many helpful kindnesses while I worked there as guest this winter.

HENRY McE. KNOWER

[1] SCIENCE, 64: 452-3.

CELLULOID CASES FOR MICROSCOPES, MICROTOMES AND BEAM-BALANCE CASES

BELL jars placed over microscopes are hazardous both to microscope and bell jar, because bell jars are cumbersome and heavy. A cone or cone frustum made of celluloid will answer as well, cost much less, be far more convenient and have a longer life than a glass bell jar.

Purchase a sheet of celluloid from a mail-order house or auto-supply store. Cut a sheet of stiff paper to form a cone to fit the microscope; use this as a

pattern for celluloid. For a large microscope piecing may be necessary. Use celloidin, or better, Dupont Duco Cement, permitting the first application to partly dry, apply a second layer of cement, hold in place with weights or pressures for ten minutes and the job is done. (I have such a cone fitted over a Leitz research microscope standing on a Chambers micro-dissection apparatus, all beautifully visible yet dust-proof.) A cone frustum would be better looking but slightly more difficult to make, though it is merely a matter of fitting in the top. It also would eliminate the piecing necessary for the cone.

By folding the celluloid over a wire frame to give better rigidity I have made a celluloid case to cover a Thoma-Jung microtome. Dr. E. P. Bartlett, seeing this, conceived the idea of making dust-proof cases for beam balances. These are folded and cemented like paper boxes.

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DEVELOPMENT OF A PERMANENT BLUE COLOR FOR COLORIMETRIC PHOSPHORUS DETERMINATION

The blue color used as a standard for Dénigés colorimetric method for the determination of phosphorus is very unstable. The color fades rapidly and a new color standard must be prepared rather frequently. By reducing a solution containing 2.5 grams of ammonium molybdate in 100 cc of 10 n. sulfuric acid a permanent blue color can be developed. The solution is reduced by stannous chloride. A dense blue color is formed which can be diluted to the desired intensity by adding 10 n. sulfuric acid. With proper dilutions a series of standards can be prepared which represent definite readings of phosphorus in parts per million.

The blue color developed under the latter condition is of a slightly different hue from the color of the reduced standard phosphorus solution but this slight difference in color is not enough to be objectionable. As a matter of fact, this permanent blue color compares as well to the unknown blue color as to the blue standard phosphate color.

The shades of blue color vary with the higher concentration of both ammonium molybdate and sulfuric acid. With the mentioned amount of ammonium molybdate in a slightly lower concentration than of 10 n. sulfuric acid a bright yellow color is produced upon reduction.

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SPECIAL ARTICLES

AN EFFECT OF SHORT ELECTRIC WAVES ON DIPHTHERIA TOXIN INDEPENDENT OF THE HEAT FACTOR

About thirty-five years ago D'Arsonval and Charrin found that high frequency currents of 200,000 cycles per second diminished the strength of diphtheria toxin. This effect was obtained without elevation of temperature to a level which would by itself affect the toxin. Since that time little has been done to develop this finding. Recent advances in short wave technique have given new impetus to the study of the biological action of these waves. It is readily accepted from many recent papers that such electrical waves may produce tremendous changes through the indirect medium of temperature elevation. Before any result is ascribed to the specific action of short electric waves, heat effect through conductivity and eddy currents must be ruled out. The chief import of this paper is to show that radiation of the type used here is capable of producing changes in biological substances independent of a heat effect.

Throughout, the wave-length was 1.9 meters and the substances to be radiated were placed between two condenser plates of a resonating circuit. The amperage in the resonating circuit was .95 to 1.2, and the frequency was 158,000,000 cycles per second.

From the beginning, and so far in this work—eliminating heat effect—completely negative results were obtained in attempts to sterilize milk and to destroy bacteria both *in vivo* and *in vitro*. Radiation *in vivo*, both as general radiation of the whole animal and local radiation to the site of injection, produced no changes in the course of streptococcus infections in guinea-pigs. In addition, no effects of the radiation could be detected on the precipitin titer of the pneumococcus antisera from rabbits.

The study of diphtheria toxin was made in two series of experiments. First series: One sample of toxin was chilled in ice water to 7° C., then exposed to radiation until the temperature had risen to 38°–40°C. (about four minutes). When such a temperature was attained the sample was taken out of the high frequency field and chilled again in the ice water. This process was repeated until the total time of radiation was fifteen to sixty minutes. A control sample was kept at the identical temperatures with the same rate of heating and cooling by alternate chilling in ice water and immersion in a small heated water bath. The temperature attained did not affect

the toxin of the control sample, but the radiated sample was definitely attenuated in as short a time as fifteen minutes.

The second series was performed with cooling during the process of radiation. The toxin was placed as a film about 0.5 mm in thickness between two walls of concentric tubes and a chilled fluid was circulated in the inner tube.[1] The type of fluid used for the cooling was found to be of very great importance, because absorption of the electric waves by the central core of cooling fluid conditioned a loss of energy available to affect the toxin. The balanced molecular structure of benzol is such that it has no resultant dipol, its dielectric constant is the same at all frequencies, and therefore no absorption bands should be anticipated. The temperature of the thin toxin layer was determined by the use of a thermocouple at all times during the course of the radiation, and additional experiments were performed to investigate any direct action of the radiation on the thermocouple. Corrections were made accordingly for this latter action. The controls in this series were placed in similar thin films and at the same temperatures. Radiation of the type described above with the benzol cooler was found to be active in producing deterioration of the toxin in thin films at temperatures as low as 15° C. Similar results were obtained with cold air as a cooler.

It is notable at this time that although D'Arsonval had pronounced that a film of toxin was necessary in such work, the toxin in our hands was not in the beginning radiated in a film with any object other than efficient cooling. Later when the means were devised to cool a full column of the toxin, the radiation on such a column was found to be ineffective at temperatures under 18° C. It is remarkable that although the physical conditions of D'Arsonval's work are very remote from those employed here, we still arrived independently at the same conclusion; namely, that a film of the toxin seems to be essential to the greatest action of the radiation.

The method of assay of the results obtained was both by skin tests in guinea-pigs and by tests of the lethality of the toxin as well. In general, so far in the work, the two methods of assay have been found to be in close parallel, with the skin test being a somewhat quicker and possibly more delicate measure. The inactivation of the toxin is not complete, but by fifteen minutes' radiation with the benzol cooler at temperatures never above body temperature, the toxicity is so diminished that twenty-five skin test doses injected intradermally into a guinea-pig give the same reaction as that obtained with one skin test dose of the control toxin. One hour's radiation makes twenty-five skin test doses equal to one half of one skin test dose, and six hours' makes fifty skin test doses (one minimum lethal dose) equal to one half of one skin test dose of the control.

[1] The efficiency of such a cooling mechanism was tested by special experiments with the whole device immersed in a water bath at 55° C. The cooler was found to preserve the toxin unchanged for three hours. Such a temperature was never approached in the radiation experiments.

The exact nature of the mechanism of the change is not clear at present, but that the action occurs without heat effect is apparent. The different responses to changes in wave-length and the action on the two other major toxins, botulinus and tetanus, together with development of methods to measure accurately the output between the plates at all times may in the future clarify the problem.

We are further interested in the suggestion of D'Arsonval that the irradiated diphtheria toxin should be investigated with regard to its properties as an immunizing substance.

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RESULTS OF TOTAL AND PARTIAL ADRENALECTOMY AND ADRENAL TRANSPLANTATION IN THE ALBINO RAT

IT has generally been considered that a large proportion of white rats will survive total extirpation of the adrenal glands, and this has been attributed to the presence of accessory adrenal tissue. In the course of experiments on the survival of adrenalectomized rats at different atmospheric pressures it soon became evident that all the control animals, *i.e.*, adrenalectomized but kept at normal atmospheric pressure, died showing the classic symptoms of adrenalectomy, *viz.*, excessive prostration, muscular weakness, anorexia, etc. On the contrary, those rats in which a small fragment was left *in situ* survived indefinitely. This was so directly opposed to the results of other investigators that we have made it a point of special study.

To date, a total of forty-eight rats has been operated on. In thirty-two of these both adrenals were removed at the same time. All these animals died, the survival period varying from three to twenty days. None of these rats gained in weight after the operation; on the contrary, there was a steady decline. Rat ♂ 2035, typical of all these cases, was at the time of operation seven months old, weighed 358 grams, was in excellent condition; it died eight days after operation and weighed 304 grams; at autopsy

it was found that the fat was entirely depleted, there were no adhesions and the wound was cleanly healed.

In five rats a very small portion of one gland was left *in situ*. All these rats survived; there was never loss in weight throughout the period they were under observation. Rat ♀ GH4126 is typical—at time of operation it weighed 167 grams, and now, 125 days after operation, it weighs 193 grams and is in excellent condition.

This, however, does not rule out the possibility of the presence of accessory adrenal tissue, and that such tissue may have taken over the function of the normal gland. To test this point we transplanted a small fragment of adrenal tissue within the ovarian capsule, inserting it through a small slit. In five successful transplants the animals showed no loss in weight and appeared indistinguishable from normal animals for an indefinite time. Two of these rats are still living and are in perfect condition. Three were observed for approximately a month, at the end of which time the ovary containing the transplant was removed. Had accessory tissue been present, these three rats should have survived, since the second operation did not involve the site of the first, and removal of one ovary does not interfere with the normal condition of the animal. But following the removal of the ovary, in each case, there was the gradual loss in weight characteristic of adrenalectomized animals, and the usual train of symptoms appeared. One died within eight days. The other two died within fifteen days.

This work shows that the rat is no exception to the rule; it does not survive complete adrenalectomy, and that very small fragments left *in situ* or successfully transplanted within the ovarian capsule suffice to keep the animal alive and in good condition.

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THE METABOLISM OF THE BRUCELLA GROUP IN SYNTHETIC MEDIA

MANY important questions concerning the biology of the Brucella group remain unsolved. As a part of an extensive program an effort has been made to analyze the elementary food requirements according to the principles evolved by Braun. After considerable experimentation a series of synthetic media in which 22 strains of the Brucella grow freely have been developed. Doubly distilled water, highly purified chemicals and Pyrex glassware have been used in the experiments. The growth, although moderate in the first generation, has improved after the fifth passage, indicating a gradual adaptation of the strains to the protein- or peptone-free environment. The following facts are worthy of note.

Cystine is one of the essential N-sources. Asparagine in combination with cystine enhances multiplication. Sodium or ammonium citrate serve as carbon and energy sources. Cultures of recently isolated strains are obtained provided sodium carbonate and potassium acid phosphate is mixed in concentrations which will give a pH of 7.0. In all probability the CO_2 thus evolved fulfils the requirements of the sensitive strains. Twenty parts per million of iron either as ferrous or ferric ion has a stimulating effect. Glycerol is not indispensable but in concentration of 2 per cent. enhances the growth of every Brucella type. Physical and not chemical factors are responsible for the growth-promoting properties of this alcohol. The surface tension and physical consistency of the substratum play an important rôle. In liquid synthetic media the growth is sparse but the addition of 0.2 per cent. agar repeatedly washed in distilled and redistilled water accelerated the multiplication many fold. In this connection it is of interest that progressively increasing amounts of agar diminish the growth until it is completely inhibited at 1.5 per cent. concentration. A semisolid synthetic medium with 0.1–0.3 per cent. agar permits the cultivation of recently isolated CO_2 tolerant strains to grow at the normal oxygen tension of air.

The details of the various experiments on the N and S requirements, C and energy sources, essential cations and anions, optimal surface tension, osmotic pressure, utilization of carbohydrates, intramolecular respiration together with growth curves will be published in the *Journal of Infectious Diseases*.

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